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Selection and Quality Control of the Optimal Composition of Soils Treated with Inorganic Binders

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Annotation: This article deals with the selection of the optimal composition of soils treated with inorganic binders, the requirements for which are the determination of material consumption and quality control for the preparation of 1 m3 mixture based on the maximum density of the material in dry and wet conditions.

Keywords: content selection, cement, mix, material, gravel, sand.

At present, the country is taking comprehensive measures to improve the appearance of settlements, especially in rural areas, the construction of affordable housing, engineering and communication works and other facilities included in the development programs of the republic. At the same time, the volume of cement production in the country and the mechanisms of price formation have a negative impact on the quality and timeliness of construction of facilities within the framework of large-scale infrastructure projects planned for this year. In addition, in the development of the road industry and the construction of modern highways, the role and importance of foundations and pavements made of cement-gravel-sand, gravel-sand mixtures and soils is very important. In order to solve this problem, it is advisable to consider the cemented material as hard concrete and to rely on the standards and rules of selection of concrete composition.

Requirements for the selection of content are not specified in ГОСТ 23558-94 "Mixture of light-gravel-sand and soil, processed inorganic and viscous materials, for road and aerodrome construction" Technical conditions. These issues are difficult for all laboratories and still lead to different approaches.

For example, the choice of material composition is based on GOST 22733-2016 "Grunty. The "method of laboratory determination of maximum plotnosti" is based on determining the maximum density of the mixture, as well as the optimal humidity. However, according to this standard, GOST 22733-2016 stipulates that a large fraction of more than 10 mm in the material should not exceed 30%.

The second issue is the procedure for determining the amount of cement, the rules are not defined. In practice, each laboratory has to estimate the initial cost and make adjustments based on the test results.

Due to the fact that in practice in most cases 40 mm fractional material is used, there is no standard answer to the question of content selection and sampling for testing.

Even when choosing a composition based on the standard of cemented material GOST 23558-94, the most relevant and important issue today is the calculation of the cost of 1 m^3 of material in the recipe - is less than 1 m^3 when deposited and compacted.

As an example, let us consider a specific composition, the recipe of which was given many years ago for some concrete plants in the Republic.

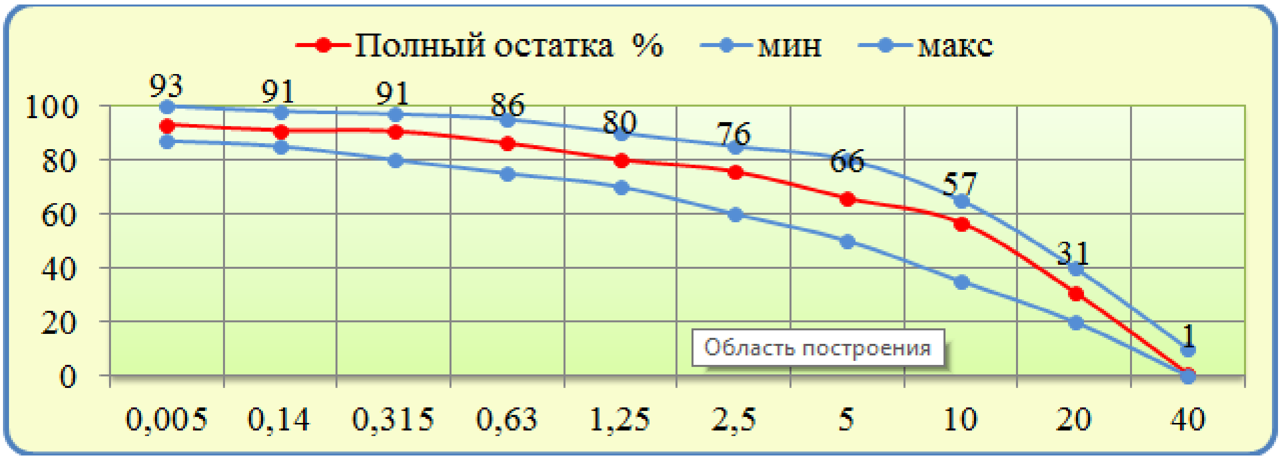
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For the selection of the composition, the granular composition of the materials was determined in accordance with Table 2 of GOST 23558-94, the gravel and in what proportions were determined.

Material	%	In sieves with a hole size of mm, the total residue by weight %,										
		40	**20**	**10**	**5**	**2,5**	**1,25**	**0,63**	**0,315**	**0,16**	**0,05**	**< 0,05**
Pebble stone fr. 5-40 mm	65	0,75	30,92	56,60	64,22	64,22	64,82	64,84	65,0	65,0	65,0	65,0
Natural sand	35	0,0	0,0	0,09	1,58	10,94	15,23	21,18	25,64	25,90	28,18	35,0
total 100%	100	**0,75**	**30,92**	**56,69**	**65,80**	**75,76**	**80,06**	**86,18**	**90,64**	**90,90**	**93,18**	
ГОСТ 23558-94		10 to	20 to 40	35 to 65	50 to 80	60 to 85	70 to 90	75 to 95	80 to 97	85 to97	87 to100	



Then, the maximum density and optimum moisture content, as in the case of soils, are determined by adding the required amount of cement to the optimized granular composition, as it is not specified in the standard, the limit of strength and cold resistance.



The maximum density is 2.41g / cm^3.

Optimal humidity 6.1%.

The sample density is 2.25g / cm^3.

Based on the maximum density of the material in the dry state, the consumption of materials for the preparation of 1 m^3 of the mixture is determined.

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Material	Laboratory content,% (mixture contains more than 100% water)	Production composition,% (water in the mixture 100%)	Percentage of material for 1 m^3 of mixture, kg
Pebble 5 - 40 mm	65,0	58,5	1365
Natural sand	35,0	31,5	735
Cement	4,8	4,3	100
Water	6,1	5,7	134

Note:

1. In determining the consumption of materials, the density coefficient is determined relative to 0.98. 2.25x0.98 = 2.20g/cm^3. Here: 2.25 is the maximum density of the material in the dry state
2. Determination of cement consumption: (ChQA) = 2200 / 1,048 = 2100kg/m^3. Then, S = 2100x0,048 = 100kg/m^3.
3. Determination of flint consumption: shch = (ChQA) 65% = 2100x0.65 = 1365kg/m^3,
4. Determination of sand consumption: P = (ChQA) 35% = 2100x0.35 = 735kg/m^3.

The manuals specify the content selection in this order. Now, in practice, with this content, when the material is removed and laid on the object, 1 m^3 of material brought in as 1 m^3 does not come out.

This is also seen when the consumption of materials determined in accordance with GOST 22733-2016 in relation to its density, it turns out that 1 m3 of material is actually 0.95 m^3.

Material	Production composition,% (water in the mixture 100%)	Percentage of material for 1 m^3 of mixture, kg	Material density, kg / m^3	Size
Pebbles fr. 5 - 40 mm	58,5	1365	**2,650**	**0,52**
Natural sand	31,5	735	**2,690**	**0,27**
Cement	4,3	100	**3,100**	**0,03**
Water	5,7	134	**1,000**	**0,13**
Total	100,0	2334		**0,95**

Let's consider the selection of the content according to the calculation methods specified in the standard ГОСТ 27006-2019 "Concrete. Rules of selection".

Accordingly, if we see in the example of method 1 of the granular composition of the gravel-sand mixture, after ensuring compliance with Table 2 of ГОСТ 23558-94, the hardness of the mixture (hardness (11-20 seconds)) can be determined. The required amount of water is determined by the weather conditions, taking into account weather conditions (air temperature above 200C or drying of the mixture due to wind), the distance from the plant to the object.

According to the calculation part specified in ГОСТ 27006-2019

1. Amount of water: 134 kg
2. Quantity of cement: 100 kg
3. Determine the absolute volume of fillers: Vz = 1000 - V / ɣv - S / rs-Vvv = 1000-134 / 1-100 / 3.1 = 834 l
4. Determining the amount of sand: P = Vz * r * rp = 0.35 * 834 * 2.69 = 786 kg
5. Volume of large filler: Ch = Vz (1-r) = 834 * (1-0,35) = 542 l
6. Determining the amount of gravel: Vch = (K * rch) = 542 * 2.65 = 1436 kg

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Material	Percentage of material for 1 m^3 of mixture, kg
Chaqiqtash fr. 5 - 40 mm	1436
Natural sand	786
Cement	100
Water	134
Total:	2455

In conclusion, it can be said that if, according to the composition selected in this way, for example, 3 prisms are prepared in the amount required to reach the mold, it will exceed the prepared sample when it is thoroughly compacted. This means that more than $1m^3$ can be extracted from the plant to the facility as $1m^3$ and compacted.

Therefore, regardless of the method chosen by each laboratory, it is necessary to test its actual, actual consumption in an experimental way, to ensure that the material given as 1 m^3, after laying and compacted on the object, will yield 1 m^3.

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